Measurement of ϒ suppression in Au+Au Collisions at 200 GeV
Shawn Whitaker, for the PHENIX Collaboration

PH✦ENIX
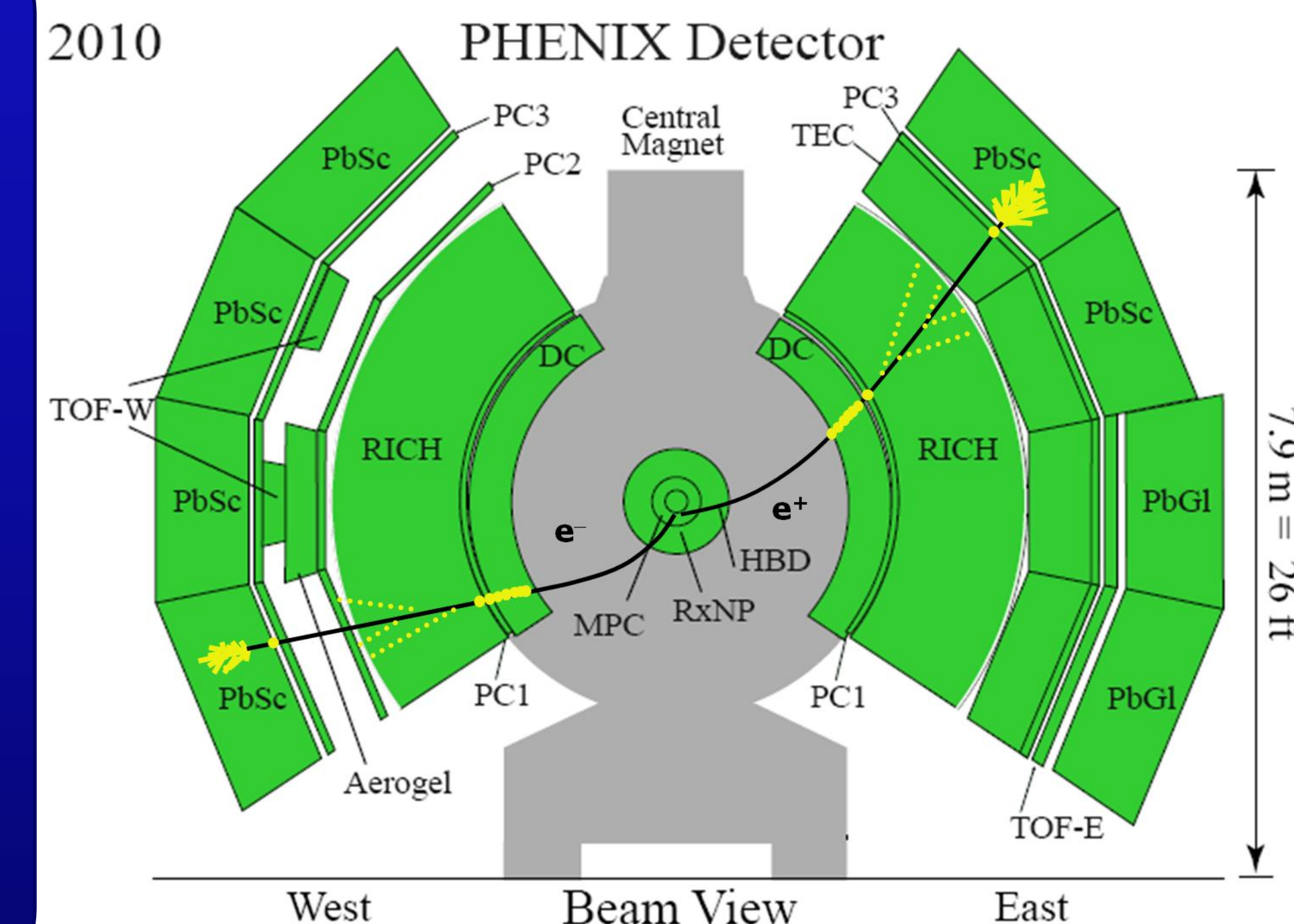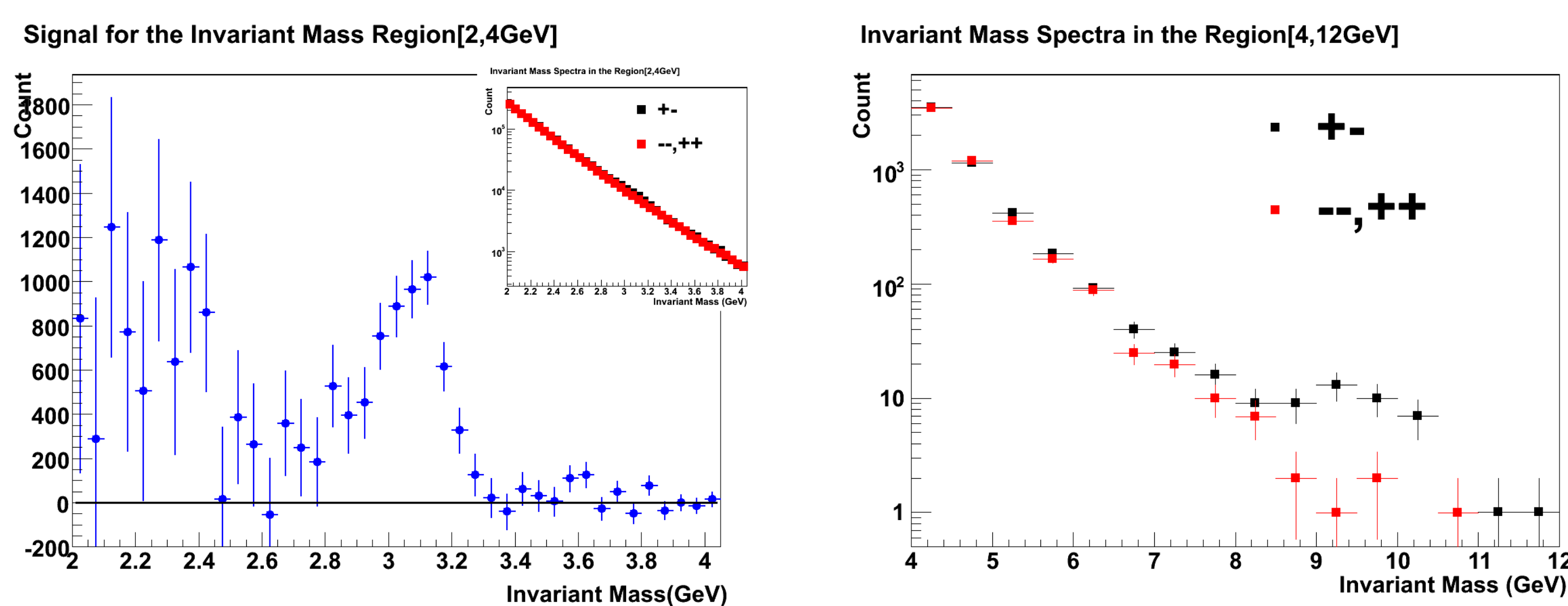
IOWA STATE UNIVERSITY

Introduction

- Quarkonia have been suggested as experimental signature of deconfinement by Matsui and Satz [1].
- Color screening in a deconfined QCD medium will suppress the existence of quarkonium states, signaling the formation of QGP in heavy-ion collisions.
- The dissociation pattern of the different quarkonia may provide an effective thermometer of the medium
- Lattice gauge theory provide an estimate of the dissolution temperature
  - The 1S charmonium ground state [J/Ψ] and excited bottomonium states [ϒ(2S) and ϒ(3S)] are expected to dissolve at temperatures about 250MeV
  - The ground state of bottomonium [ϒ(1S)] is expected to dissolve at temperatures above 450MeV

Electron Detection in PHENIX

- **PHENIX Central Arms**
  - $|\eta|<0.35$
  - $\Delta\varphi = 2 \times \pi/2$
  - $p > 0.2$GeV/c
- **Electron ID:**
  - Cherenkov light RICH
  - Shower EMCal
  - Lead scintillator calorimeter (PbSc)
  - Lead glass calorimeter (PbGl)

J/ψ and ϒ Reconstruction

Signal for the Invariant Mass Region[2,4GeV]

Invariant Mass Spectra in the Region[4,12GeV]

- PHENIX can reconstruct quarkonia from their di-electron and di-muon decay channels. This analysis uses the di-electron channel.
- Particles that produce photo-electrons in the Ring Imaging Cherenkov detecter and depositing a large fraction for their energy in the Electro-Magnetic Calorimeter are identified as electrons.
- The invariant mass distribution is calculated for all oppositely charge electron pairs and is represented by the black squares above.
- The combinatorial background is estimated by using same sign electron pairs represented by the red squares above.
- The net signal is estimated by subtracting the combinatorial background from the opposite sign invariant mass spectra shown as blue circles above for the J/ψ region. The ϒ signal is clear from the unlike sign distribution.

Removing the Correlated Continuum Contribution

Signal for the Invariant Mass Region[2,4 GeV]

Signal for the Invariant Mass Region[4,12 GeV]

- The net signal distribution is made up of the quarkonia resonances as well as a continuum distribution of di-electrons from charm and bottom semi-leptonic decays and drell yan.
- The invariant mass distribution of the continuum contribution is expected to have a rapidly falling exponential shape.
- To characterize the resonance yield the net signal invariant mass distribution was parameterized with an exponential + Gaussian function.
- The yields were estimated by direct counting above the exponential fit and are shown in the table below.

Resonance Yields

Mass Region	N(-+,+-)	Comb. Background	Signal
J/ψ [2.8, 3.4 GeV]	1.285×10^5	1.223×10^5	$(6.23\pm0.69)\times10^3$
Upsilon [8.5, 11.5 GeV]	40	6	34 ± 7
	Signal	Corr. Continuum	Yield
J/ψ [2.8, 3.4 GeV]	$(6.23\pm0.69)\times10^3$	$(1.28\pm0.46)\times10^3$	$(4.95\pm0.83)\times10^3$
Upsilon [8.5, 11.5 GeV]	34 ± 7	5.2 ± 4.2	29 ± 7.9

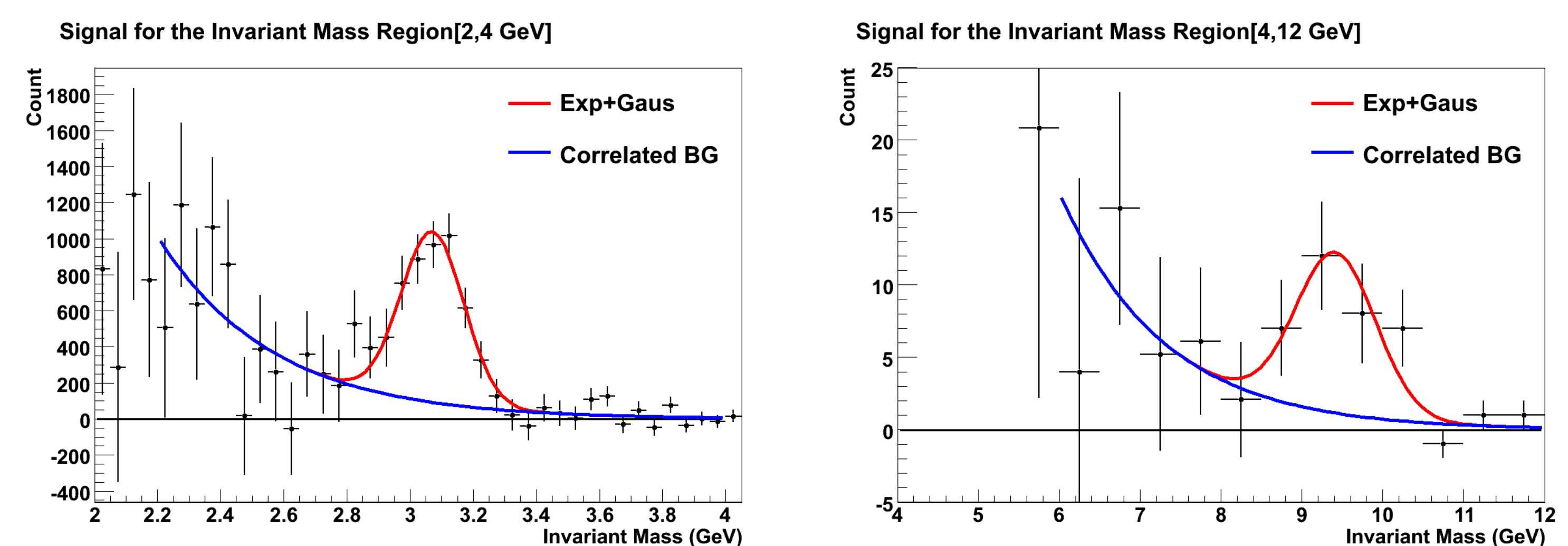## Calculating $R_{AA}(\Upsilon)$

$$R_{AA}^{MB}[\Upsilon] = \frac{(N[\Upsilon]/N[J/\psi])_{AA}}{(N[\Upsilon]/N[J/\psi])_{pp}} \times \frac{(A\varepsilon[J/\psi]/A\varepsilon[\Upsilon])_{AA}}{(A\varepsilon[J/\psi]/A\varepsilon[\Upsilon])_{pp}} \times R_{AA}^{MB}[J/\psi]$$

From previous analyses we already have the following terms

$$(N[\Upsilon]/N[J/\psi])_{pp} = (3.96 \pm 1.4 \pm 0.924(sys)) \times 10^{-3}$$

$$R_{AA}^{MB}[J/\psi] = 0.425 \pm 0.025(stat) \pm 0.051(syst) \pm 0.051(glob)$$

Further Analysis Needed

Work still needs to be done calculating

$$(A\epsilon[J/\psi]/A\varepsilon[\Upsilon])_{AA}$$

Via Simulation studies
- Acceptance differences for J/ψ and ϒ
- Efficiency differences for J/ψ and ϒ decay electrons
- Material effects on resonance shapes and effect on yields

Reference: [1] T. Matsui, H. Satz, Phys. Lett. B 178 (1986) 416.